10. STARTER MOTOR

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10–1. Description

A shift-lever type starter motor is used for cranking the engine. The motor is mounted on the cylinder block, with its drive pinion meshed with the ring gear of the flywheel. In the following illustration, note that the whole motor assembly inclusive of the magnetic switch and lever mechanism is enclosed.

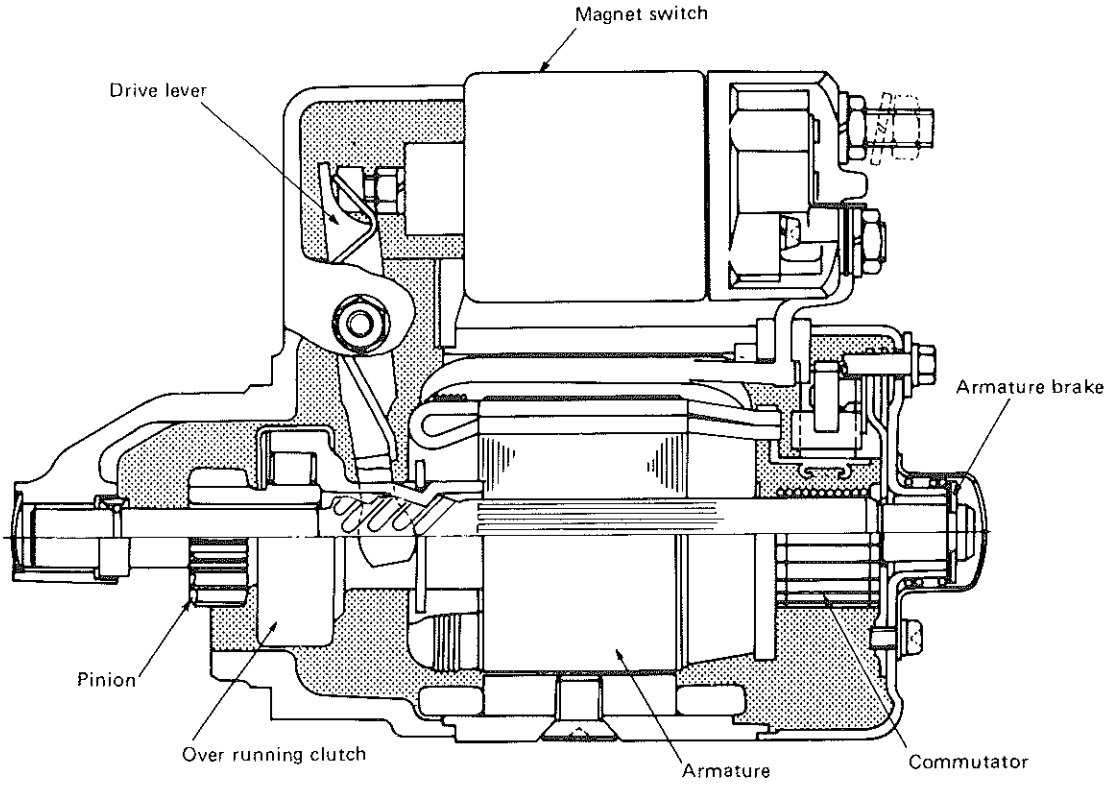

Fig. 10-1

10–2. Specifications

Voltage	12 volts
Output	0.6 kW
Rating	30 seconds
Direction of rotation	Counterclockwise as viewed from pinion side
Brush length	19 mm (0.75 in.)
Number of pinion teeth	9
No-load characteristic	55 A maximum at 11 volts, 3,500 rpm minimum
Load characteristic	230 A maximum at 9.5 volts and 0.5 kg-m torque, 2,000 rpm minimum
Locked rotor current	450A maximum at 8.5 volts, 1.1 kg-m minimum
Magnetic switch operating voltage	8 volts maximum

10–3. Cranking Action

Starting up the motor

Turning on the starting switch results in a small current flowing throught the holding coil and another through the pull-in coil, both in the magnetic switch. The former current flows direct into ground, but the latter flows through motor armature and field. In other words, motor begins to run. In the magnetic switch, the two coils energized—pull-in coil and holding coil—develop a combined magnetic pull, by which the moving core is pulled against the force of the spring and moves toward the right (in the illustration). At this time, the motor armature is running but slowly because of the small initial current. As the moving core is forced toward the right, its left end turns the shift lever around its pivot, so that the bottom end of the lever pushes the clutch toward the left. Since the clutch is splined to the motor shaft and because the motor shaft is rotating, the clutch advances toward the left as assisted by the helical splines.

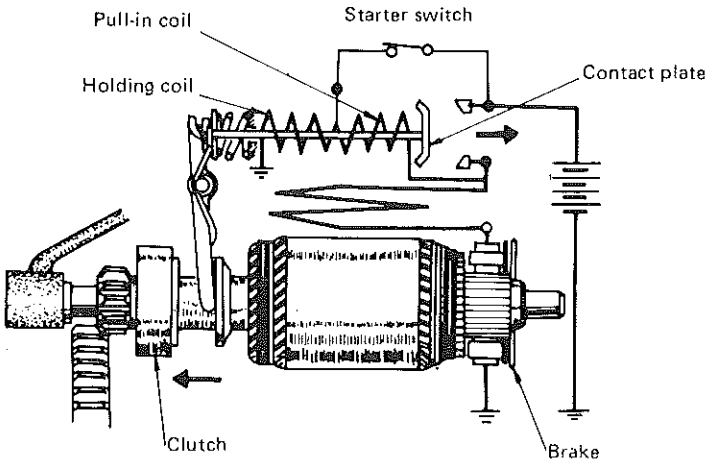

Fig. 10-2

Pinion meshing with the ring gear

The pinion may mesh into the ring gear smoothly or may bounce on the ring gear, depending on the relative positions of their teeth. In the latter event, the springs mounted on the clutch absorb the shock and, since the pinion is rotating and being pushed, its teeth will eventually mesh into those of the ring gear. In either case, the shift lever is allowed to turn fully and permit the moving core to be kept pulled all the way toward the right. When this happens, the main contactor of the magnetic switch closes to connect the starter motor direct to the battery. Consequently, a very large current—load current—flows through the motor to develop a high cranking torque for driving the engine crankshaft through the drive pinion and ring gear.

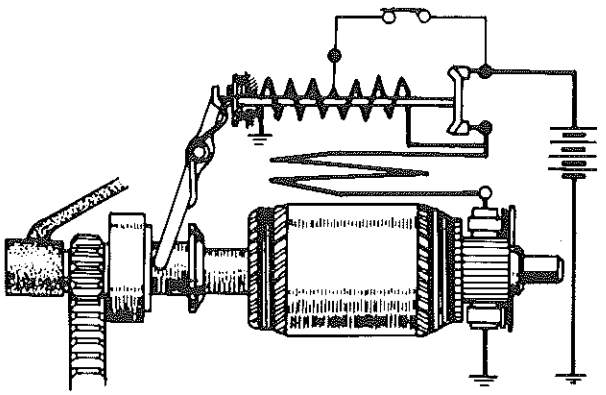

Fig. 10-3

Engine cranking

When the motor is cranking the engine with full force, the pull-in coil is bypassed or shunted but the holding coil remains energized to hold the moving core in its shifted position. Under this condition, the shift lever is pushing the pinion by overcoming the force of springs.

As the engine fires up and begins to run steadily and if the starting switch is kept closed, the ring gear starts driving the pinion. When this occurs, the pinion merely spins on the motor shaft without transmitting this reverse drive to the motor. This is because the clutch is of overrunning type.

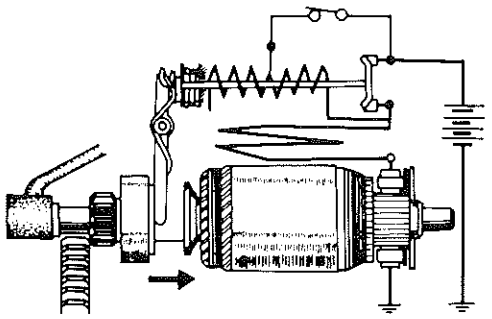

Fig. 10-4

Terminating cranking operation

Turning off the starting switch de-energizes (shutting off the current) the holding coil so that the pull hitherto acting on the moving core disappears. By the force of the spring, then, the shift lever is turned back and the moving core is forced toward the left to open the main contactor. This shuts off the load current, and the drive pinion, shift lever and moving core go back to their original positions.

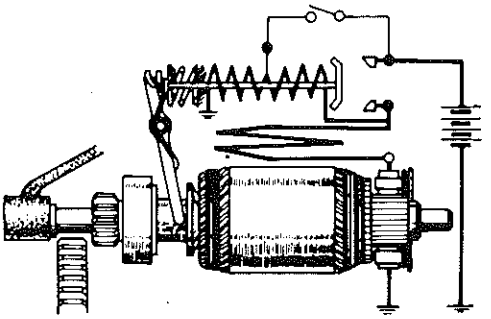

Fig. 10-5

10–4. Removal

1) Disconnect battery cable from the negative(–) terminal of the battery.

2) Disconnect the plus cord (+) and BLACK/YELLOW lead wire from the starter motor.

3) Remove the two bolts securing the starter motor assembly to the cylinder block, and take off the starter motor.

10–5. Disassembly

1) Remove the nut securing the end of the field coil lead to the terminal on the head of magnetic switch.
2) Take off the magnetic switch ① from the starter motor body by removing the two mounting screws.

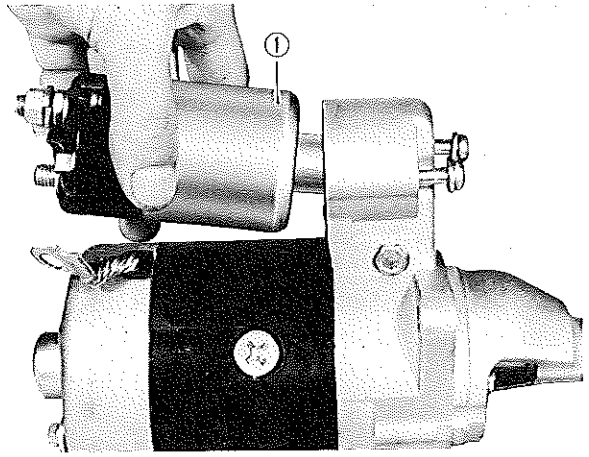

Fig. 10-6

3) Remove the bearing cover ②, and take out lock plate brake spring ③ and rubber ④.

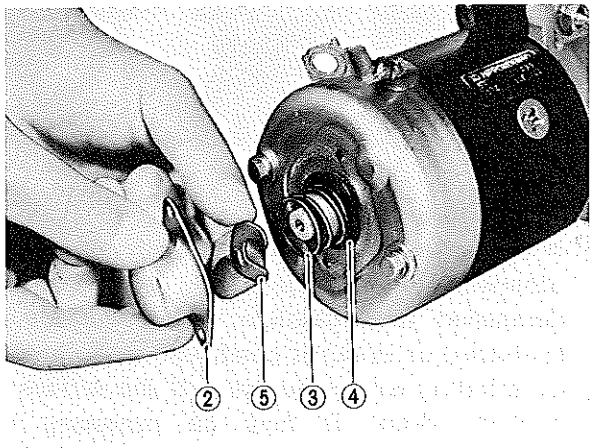

Fig. 10-7 ⑤ *Clip*

4) Disassemble the brush holder section in the following sequence:
   (1) Remove two through bolts.
   (2) Detach commutator end frame.
   (3) Draw brushes out of the holder.
   (4) Take out the brush holder.

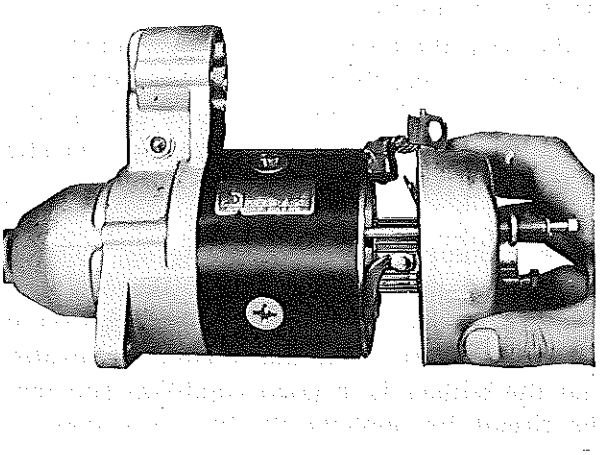

Fig. 10-8

5) Remove the case complete with field coils.
6) Pull off the set pin from shift lever, and take out the rubber and plate inside the housing.
7) From the housing, take out the armature, starter clutch and shift lever.

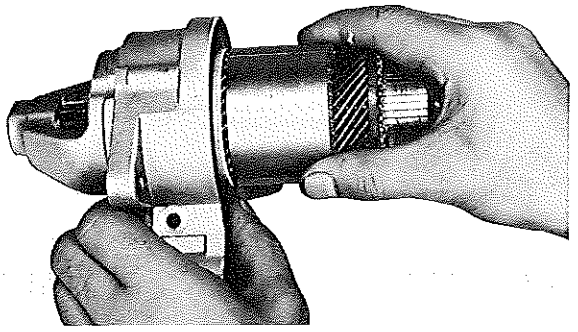

Fig. 10-9

8) Draw off the starter clutch, as follows:
   (1) Draw stop nut toward the clutch side.
   (2) Remove snap ring and slide off clutch.

10–6. Maintenance Services

In the event the starter motor is found unable to crank the engine, the first thing to be checked is whether the drive pinion plunges out. If the pinion does not plunge out, then the magnetic switch must be checked.

If the pinion plunges out satisfactorily, then the inability of the motor to crank the engine is likely to be due to some defective condition in the commutator or in the armature, provided that the battery is in good condition and that the circuit for applying the battery voltage to the motor is free from any open or fault. Having narrowed the scope of search for the cause of trouble to the motor proper, proceed as follows:

Checking the field coils

Check to be sure that the field circuit is neither grounded or open-circuited. This can be effected by using a circuit tester as shown. If continuity is indicated by the tester hooked to the housing or frame, it means that the insulation has failed, resulting in a grounded field coil. Such a fault can be corrected by repair in most cases.

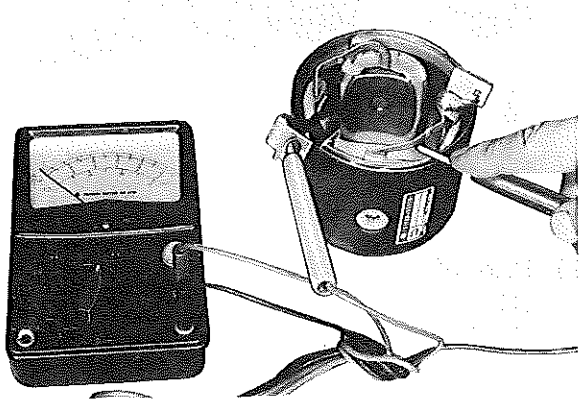

Fig. 10-10

Checking the armature

- Using the circuit tester, see if there is any continuity between commutator and armature core. The tester will indicate infinite resistance if the insulation is in sound condition.

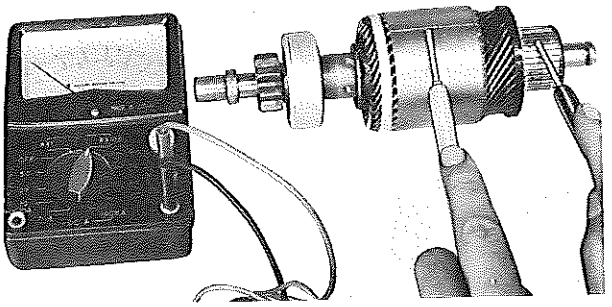

Fig. 10-11

- Again using the tester, check for continuity between each pair of adjacent commutator segments. If discontinuity is noted at any part of the commutator, replace the whole sub-assembly of the armature.

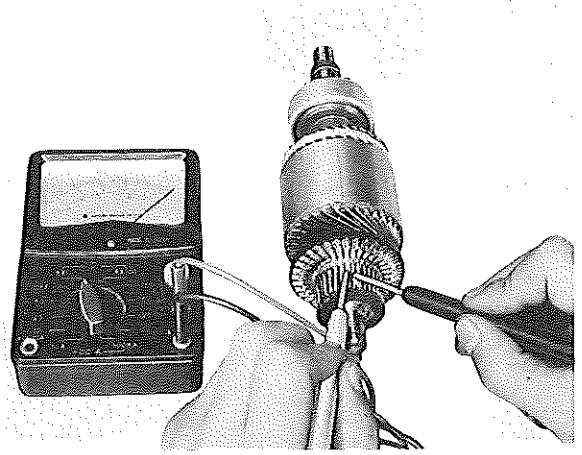

Fig. 10-12

Servicing the commutator

- If the surface of the commutator is gummy or otherwise dirty, wipe it off with a cloth dampened with gasoline. If the surface is coarsened or in burnt condition, smoothen it by grinding with sandpaper. If the surface is grooved deep, it may be necessary to remove the groove marks by turning the commutator in a lathe; such turning is often successful in reconditioning the commutator if the extra stock necessary for removal by cutting is available without reducing its diameter to the limit.

	Standard
Commutator diameter	32.5 mm (1.28 in.)

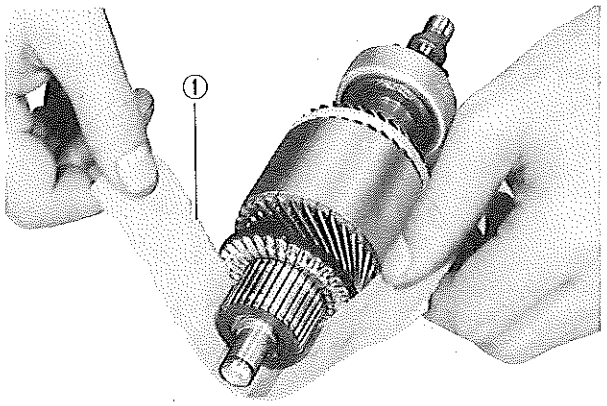

Fig. 10-13 ① *Sand paper*

- Make sure that the mica between each pair of adjacent segments is undercut to the prescribed depth. The conventional undercutting technique is to be used in repairing the commutator.

	Standard	Service limit
Mica undercut	0.5 ~ 0.8 mm (0.02 ~ 0.03 in.)	0.2 mm (0.007 in.)

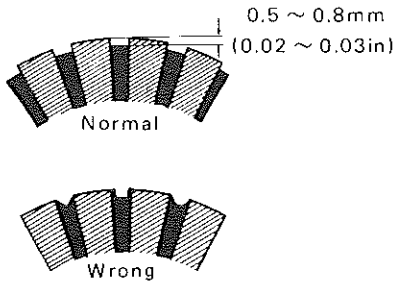

Fig. 10-14

Testing the magnetic switch

Before separating the magnetic switch from the motor proper just removed from the crankcase, test the switch by connecting the battery to the switch, as shown, to see if the drive pinion jumps out when the battery voltage is applied. (With the positive terminal of the battery cable end.) With the switch coils in sound condition, the drive pinion will jump out and, even when the main circuit is opened at "A", will remain in "jumped out" position. If undoing the connection at "A" causes the drive pinion to retract, it means that the holding coil is defective.

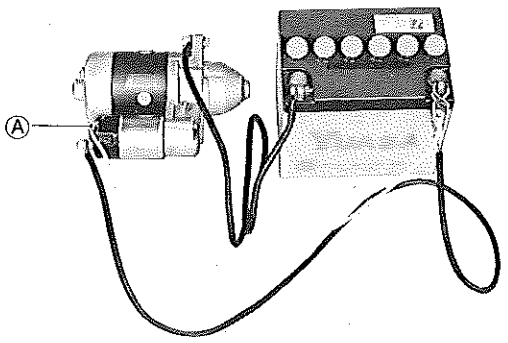

Fig. 10-15

Servicing the brushes

Check the length of each brush. If brushes are worn down to the service limit, replace them.

	Standard	Service limit
Brush length	19 mm (0.75 in.)	12 mm (0.47 in.)

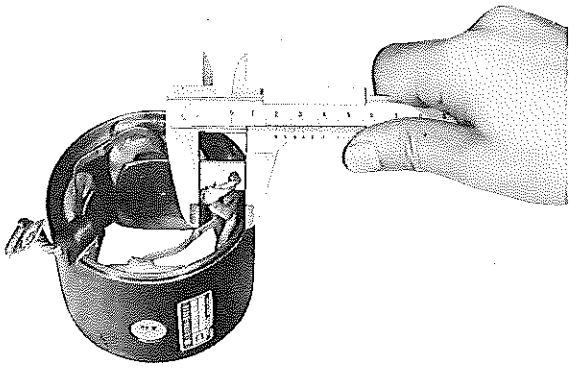

Fig. 10-16

Servicing the brush holders

Make sure that the insulation between the two brush holders, positive and negative, is in good condition. This should be verified with the use of the circuit tester. If any continuity is noted, repair the insulation.

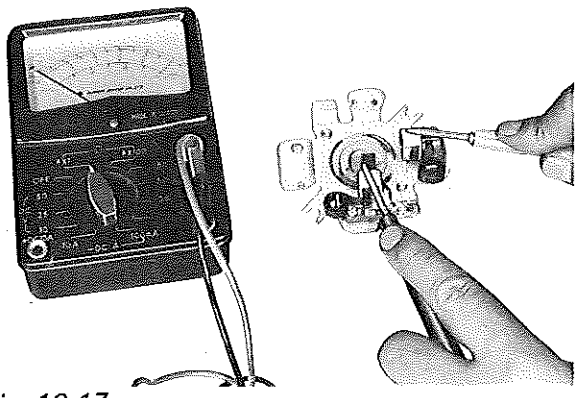

Fig. 10-17

10–7. Important Reminders for Starter Motor Reassembly

Various parts of the starter motor assembly need lubrication at each overhaul. The lubrication points are illustrated below: (Also required is locking by punching.)

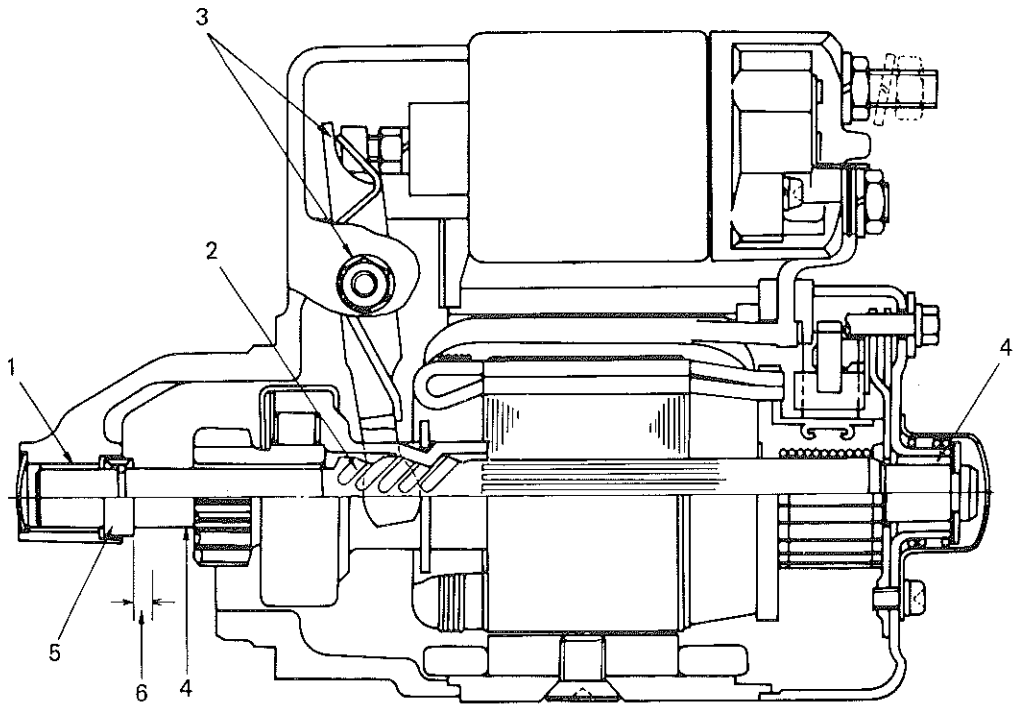

Fig. 10-18

1) Give grease to the bush in the drive housing.

2) Grease the helical splines before mounting the clutch sub-assembly.

3) Grease the sliding or contacting surfaces associated with shift lever.

4) Grease the bush fitted into the end frame and also the armature shaft end inserted into this bush.

5) After installing the stop nut, lock it by staking at two places with a punch.

6) Adjust the length of the moving stud so that the clearance between the stop nut and the pinion in plunged-out condition will be from 1 to 4 mm (0.04 to 0.16 in.). To check, run the motor in no-load condition to plunge out the pinion and wait till the motor speed settles.